CEO equity incentive, board gender diversity, and share repurchases

Abstract

This study investigates the effect of CEO equity incentive on share repurchase. We further consider the influence of board gender diversity on the relation between CEO equity incentives and share repurchase. Using a sample of the Taiwan Stock Exchange and Taipei Exchange listed companies from 2002 to 2016, we document that, relative to lower equity incentive, CEOs with higher equity incentive are more likely to buy back shares, in particular when their stock prices are perceived as undervalued. Furthermore, we also find that board gender diversity *mitigates* the relation between CEO equity incentive and share buyback.

Keywords: *CEO equity incentive, Repurchases, board gender*

1. Introduction

Existing literature examines whether CEO equity incentive affects share repurchases, but with mixed results. Some studies show that CEO equity incentive affects the amount of share repurchases in the United States and Europe. Repurchases are more likely in firms that have more equity incentive due to offset EPS dilution caused by the use of employee stock options (Fenn and Liang 2001; Kahle 2002; Bens et al. 2002; Burns, McTier and Minnick 2015; Cheng, Harford and Zhang 2015; Tan and Young 2016; Kim and Ng 2018). However, other research finds a statistically insignificant relationship between repurchase activities and CEOs stock options or bonus (Liljeblom and Pasternack 2006; De Cesari and Ozkan 2015; Cheng, Harford and Zhang 2015). Therefore, clear evidence concerning the effect of CEO equity incentive on share repurchase is still lacking in the literature. Unlike prior research that only uses the percentage of CEO's ownership or beneficial ownership (stock option or equity bonus as equity compensation) as a proxy for equity incentives, we follow Core and Guay (1999) to measure the CEO equity incentives as "the change in CEO wealth for a 1% change in firm value" which considers the relation between CEO's personal ownership (including CEOs' direct investment in a firm's stock, as well as equity compensation) and firm value.[1] In this study, we aim to provide direct evidence as to whether CEO equity incentive affects repurchase.

When CEOs have higher equity ownership, their welfare is directly tied to firm value. CEOs' personal wealth changes as a result of share price changes; this provides equity incentive (Jensen and Murphy 1990; Yermack 1995; Core and Guay 1999; Sanders 2001). The closer the linkage between the personal wealth of CEOs and the share prices of the companies, the stronger the equity incentive effect of CEO ownership.[2] High share prices generally lead to high value of the equity promised to the CEO. Therefore, CEOs concerned about their equity value are motived to promote firm value through share repurchase (Amihud and Lev 1981; Walking and Long 1984; Fried 2011) in order to increase the value of their own equity stake. This study expects that firms buy back shares more often when the CEOs have higher equity incentives, as measured by the change in CEO wealth for a 1%

[1] Compared to using the percentage of share CEO owned, Sanders (2001) suggests that the value of stock owned by a firm's CEO provides the wealth effect of CEO ownership. Core and Guay (1999) suggest that the explanatory power of the measure of CEO equity incentives is substantially greater than for an incentive measure that consists solely of CEOs' ownership.

[2] We follow Core and Guay (1999) to measure the excess equity incentive which is the deviation between CEOs' holdings of equity incentives and optimal levels (see section 3).

change in firm value.

Other than the CEOs equity incentive, the literature exploring the incentives for share repurchases documents *positive* economic incentives such as signaling undervalued share prices (Vermaelen 1981; Stephens and Weisbach 1998) and distribution of free cash flows (Jensen 1986; Stephens and Weisbach 1998).[3] The former is called the information signaling hypothesis, which states that share repurchase announcements are a means of conveying positive information about future earnings prospects by reducing information asymmetry (Otchere and Ross 2002). The latter is called the free cash flow hypothesis, which suggests that repurchasing shares is a way to distribute a firm's excess cash flow to avoid over-investment (Easterbrook 1984; Jensen 1986). According to these two hypotheses, the announcements for share repurchases may be viewed as a signal to investors about future performance, to which the market may respond favorably (Lie 2005; Liang, Chan, Lai and Wang 2013). However, the economic incentives (*stock is undervalued or free cash flows*) of share repurchases may *differ* for CEOs, depending on their self-interest motivations. The management incentive hypothesis contends that the higher the management remuneration or ownership, the more likely the announcements for share repurchases (Vafeas 1997; Jolls 1998; Dittmar 2000; Fenn and Liang 2001; Kahle 2002; Bens et al. 2002; Tsai and Kou 2004; Chan, Tai, Chan and Li 2012; Burns, McTier and Minnick 2015). This suggests that managers intend to boost share prices and buy back shares for boosting their personal wealth (Jensen 2005). CEOs have higher propensity to repurchase shares when they believe the stocks are undervalued. Under this scenario, CEOs are motivated to enhance firm values and shareholding values via buying back shares. This paper further expects that CEOs with high equity incentive are more sensitive to undervaluation of firm values when making repurchase decisions.

On the other hand, according to the free cash flow hypothesis, repurchases are more likely in firms that hold high levels of excess cash (e.g., Andriosopoulos and Hoque 2013). However, if CEOs equity incentives are high, the agency problem resulting from free cash flows will be mitigated (Haugen and Senbet 1981). This implies that CEOs' equity incentives can mitigate the over-investment of free cash flow. We thus expect that CEOs with higher

[3] Other than the undervaluation of share prices and the redistribution of cash flows, the incentives of stock buybacks include an increase in debt ratios, anti-takeover measures (Dittmar 2000) and share issues (by using treasury stocks) to employees (Dittmar 2000; Chan, Tai, Chan and Li 2012). We consider these incentives by including them as control variables in the analyses.

equity incentive are less sensitive to excess free cash flow when making repurchase decisions.

Prior research regarding CEOs' equity incentives posits two competing effects: the interest alignment effect (Fama and Jensen 1983; Jensen and Meckling 1976; Holmstrom 1979) and an opportunistic effect (or managerial entrenchment effect) (Vafeas 1997; Goldman and Slezak, 2006; Duellman, Ahmed and Abdel-Meguid 2013; Armstrong, Larcker, Ormazabal and Taylor 2013). Duellman et al. (2013) find that the incentive alignment (opportunistic) effect of equity incentives increases (decreases) as monitoring intensity increases (decreases). According to governance hypothesis, female directors allocate more effort to monitoring and improving corporate governance.[4] CEOs' opportunistic behavior decreases or the incentive alignment effect increases, in firms with high board gender diversity. This study further investigates whether board gender diversity affects the relationship between equity incentives and repurchases.

Using a sample of the Taiwan Stock Exchange and Taipei Exchange listed companies from 2002 to 2016, the empirical results show that, on average, CEOs with higher equity incentive are more likely to buy back shares. In addition, the effect of CEO equity incentive on repurchase is more pronounced when the stock is undervalued, compared with the distribution of free cash flows. In other words, when CEOs have a closer linkage between their personal wealth and the share prices of the companies, they are more motivated to buy back stocks, especially when the stocks are undervalued. However, we do not find that this correlation exists in the free cash flow hypothesis. We also find that board gender diversity mitigates the correlation between CEO equity incentive and buyback, which is consistent with the governance hypothesis that CEOs' opportunistic behavior decreases with board gender diversity.

This paper adds to the body of research that investigates why firms repurchase stocks by considering the interaction of managers' self-interest and economic incentives. Research in this area typically examines the repurchase motivations from either one view of economic incentives, such as undervalued share prices and the distributed free cash flows, or the other view of CEOs equity incentives. In contrast, we recognize that CEOs treat the economic

[4] Female directors improve monitoring (Adams and Ferreira 2009), reduce agency cost of equity (Gul et al. 2001), and buy back shares to reduce agency costs of free cash flow (Evgeniou and Vermaelen 2017).

incentives different, especially when CEOs have high self-interest motivations.[5] In addition, we use a more comprehensive measure of CEOs' self-interest as the change in CEO wealth for a 1% change in firm value (Core and Guay 1999). This proxy allows us to directly measure the equity incentive of CEOs compared to the percentage of CEO ownership or equity compensation. Finally, we also find that boards with female directors are tougher monitors than all-male boards, as reflected by the use of share repurchase as a self-interest tool of CEOs, which is consistent with the governance hypothesis.

The remainder of this paper is organized as follows. Section 2 summarizes the literature review and develops the hypotheses. Section 3 describes the research design and variable measurement. Section 4 provides the empirical findings and interpretations. Section 5 presents the conclusions and suggestions.

2. Literature Review and Hypothesis Development

1) Literature review on share repurchases: motivations and performance

Prior literature addressing share repurchases examines the following issues: (1) motivations of share repurchases; (2) market responses to share repurchase announcements; (3) long-term performance after share repurchase announcements. Most of the literature delving into the repurchase motivations documents positive economic incentives, such as companies having undervalued share prices, or excess free cash flows (Dittmar 2000; Tsai and Kuo 2004; Cheng, Lin and Hsu 2006). Other studies indicate that companies buy back shares as an anti-takeover measure when they are under the risk of being acquired (Dittmar 2000). Some studies look at the issues from the managers' self-interest motivation. The share repurchase propensity grows when a high percentage of shares owned by directors and supervisors are pledged (Cheng et al. 2006), the percentage of management ownership is high (Vafeas 1997; Jolls 1998; Dittmar 2000; Tsai and Kuo 2004), or the CEO also serves as a board director or chairperson (Chen and Le 2012). Young and Yang (2011), Tan and Young (2016) and Kim and Ng (2018) contend that if earnings per share (EPS) are used as a performance indicator in remuneration contracts, managers also tend to buy back shares to raise EPS and hence their compensation. However, different firm characteristics lead to

[5] Cheng et al. (2006) use listed firms in Taiwan to examine whether ownership by directors and supervisors affects the economic incentives of share repurchases. However, they do not consider the interaction effect of equity incentive and economics incentives.

different repurchase motivations. The market also responds differently to share repurchase announcements accordingly. Consistent with the signaling hypothesis, the response to positive economic incentives is favorable when share repurchases signal future prospects (Comment and Jarrell 1991; Liu and Ziebart 1997; Chen and Wu 2002; Tsai and Kuo 2004; Chi, Wu and Tsai 2007). However, this favorable response may be hampered if insiders sell shares before the announcements, or when the CEO also serves as a board member or chairperson (Chen and Lee 2012). That said, the favorable response may be even more pronounced if the corporate governance is strong (Wu 2012b). Sometimes, the executed repurchases are far lower than those announced. Therefore, some studies use the completion rate (actual repurchases scaled by target shares) to differentiate repurchase motivations. Recent studies find that the higher the percentage of the completion rate, the more positive the market response (Liu and Chen 2010; Wang and Chen 2010). Kahle (2002) and Chi et al. (2007) suggest that if the repurchased shares are intended to be granted to employees, investors tend not to respond to it. Chan (2012) contends that the more frequent the share repurchases, the weaker the signaling effects. Tsai, Lin and Chih (2012) note that investors respond differently to different repurchase price ranges. Liang, Chan, Lai and Wang (2013) take into account the lifecycle of the companies. According to their study, if a firm is in the growth stage, stock repurchases are mainly for signaling. On the contrary, if a firm is in the mature stage, share repurchases may be a response to distribute excess free cash flows and limited investment opportunities.

Regarding the performance following share repurchases, it varies subject to different motivations. Some studies document that share prices rise or firm performance improves following share repurchases subject to the motivation of undervalued share prices (Barov 1991; Ikenberry et al 1995; Lie 2005; Peyer and Vermaelen 2009). This conclusion supports the signaling hypothesis. However, some studies argue that firm performance declines after share repurchases (Nohel and Tarhan 1998; Grullon and Michaely 2004). For example, Bhargava (2013) contends that share repurchases reduce available funds and hence investment profits, leading to deteriorating performance. On the other hand, Gong, Louis and Sun (2008) use return on assets to measure firm performances following share repurchases, and do not find any subsequent improvement or decline of firm performance. Chen, Huang and Wang (2011) use total factor productivity (instead of return on assets) to validate whether share repurchases are in line with the signaling hypothesis or the free cash flow hypothesis.

They find that the main purpose of share repurchases is to send a message concerning improving a firm's outlook. This is consistent with the signaling hypothesis.

Setting aside the different arguments by the information signaling hypothesis and the free cash flow hypothesis, the existing literature only verifies whether share repurchase announcements are driven by undervalued share prices or a desire to distribute cash flows, but ignores whether the CEO equity incentive affects the firm's positive economic incentive of share repurchases. If share repurchases on the basis of firm's positive economic incentives push up share prices, will the CEO equity incentive effect increase the likelihood of managers pursuing share repurchases? This paper intends to explore whether a firm's positive economic incentives for share repurchases are subject to the influence of the CEO's equity incentives. In other words, do different levels of CEO equity incentives, in terms of CEO ownership, affect whether share repurchases are driven either by undervalued share prices (the signaling hypothesis) or an intention to distribute excess cash flows (the free cash flow hypothesis)?

2) Hypothesis Development

Effects of CEO equity incentives

The literature suggests that managers' share ownership can mitigate the agency problem between managers and shareholders. A high percentage of share ownership encourages managers to work hard, and aligns the interests of managers and those of shareholders (Haugen and Senbet 1981). According to this incentive alignment hypothesis, the agency problem between shareholders and managers in firms with high equity incentive is less apparent (Fama and Jensen 1983; Jensen and Meckling 1976; Holmstrom 1979). However, recent theoretical papers suggest that equity incentives may also motivate managers to boost short term stock prices by manipulating accounting numbers, which is consistent with the opportunistic or entrenchment behavior of CEOs (see for example, Vafeas 1997; Goldman and Slezak 2006).

Prior research finds that CEOs tend to buy back stocks when they hold more stock options. Stock repurchase allows CEOs to distribute cash without diluting the EPS of the stock when they exercise their options (Fenn and Liang 2001; Kahle 2002; Bens et al. 2003; Burns, McTier and Minnick 2015). Jolls (1998), Feng and Liang (2001), and Burns et al. (2015) find that firms which have more stock options pay lower dividends. Vafeas (1997) and Fried (2005) find that high management ownership increases the likelihood of share

repurchases. Kahle (2002) further divided stock options into exercisable and unexercisable, and found that the more exercisable stock options that CEOs have, the more likely the companies are to announce share repurchases, and the higher the amount of share repurchases. However, using Finland and other European firms as sample, Liljeblom and Pasternack (2006) and De Cesari and Ozkan (2015) find a statistically insignificant relationship between repurchase activities and CEOs' stock options. Overall, the extant literature provides unclear evidence regarding how CEO equity incentive affects share repurchase policy. Unlike prior research using CEO's stock ownership (or beneficial ownership) as a proxy for equity incentives, this study follows Core and Guay (1999) in using the linkage between CEO personal wealth and firm value to measure CEO equity incentive (Core and Guay 1999).

Prior literature suggests that the repurchase announcement usually serves as a positive economic signal of benefit to investors reflecting the information signaling (undervaluation) hypothesis and free cash flow hypothesis (Liu and Ziebart 1997; Chan et al. 2004; Grullon and Michaely 2004; Wu 2012a; Liang et al. 2013). If firm value increases after repurchase, CEO personal wealth will increase. CEOs with high equity incentives signify a strong linkage between the personal wealth of CEOs and firm value (Fama 1980). Therefore, if CEOs are concerned about their equity value, they are motived to promote firm value through share repurchase (Amihud and Lev 1981; Walking and Long 1984; Fried 2011), as well as to increase the value of their own equity stakes. In accordance with the previous discussion, we posit the following hypothesis:

H1: The amount of share repurchases announced increases in tandem with the CEO equity incentives.

CEO equity incentive and economic incentive

Two major hypotheses for repurchasing shares analyzed in past studies are the information signaling hypothesis (e.g., Chan et al. 2004; Ikenberry et al. 1995; Lie 2005; Peyer and Vermaelen 2009) and the free cash flow hypothesis (e.g., Grullon and Michaely 2004; Nohel and Tarhan 1998). The information signaling hypothesis states that share repurchase announcements are a means of conveying positive information about future earnings prospects by reducing information asymmetry (Otchere and Ross 2002). CEOs tend to release private information through the share repurchases when the stock is

undervalued (Jagannathan et al. 2000; Baker, Powell and Veit 2003). Investors receive this private information and adjust their forecasts about the firm, and the stock price rises. Prior research finds that the market responds favorably to the announcement of share repurchases when firms are undervalued by the market (Otchere and Ross 2002; Lee, Ejara and Gleason 2010). If share repurchases deliver the message that share prices are undervalued, the future performances of the companies will improve following the share repurchases (e.g., Barov 1991; Lie 2005; Chen, Huang and Wang 2011). Prior research also suggests that some managers under pressure to boost stock prices use buyback announcements to mislead investors (Chan et al. 2010; Liu and Swanson 2016). Given that CEOs with high equity incentive are more likely to believe their stock is underpriced in general, we would expect them to react more to undervalued share price. In sum, the information signaling hypothesis suggests that a firm has an incentive to buy back its own shares as a good self-investment signal when its stock price is undervalued. Therefore, it can be inferred that in case of undervalued share prices, CEOs with high equity incentives are more likely to repurchase shares to increase their own personal wealth. Following the literature, we use abnormal book to market ratio to measure the level of undervalued price to control the difference between repurchase firms and non-repurchase firms (Liang et al. 2013). On the basis of the above literature review, this paper posits the following hypothesis:

H2a: The relationship between abnormal book-market ratio and share repurchases increases with the CEO equity incentives.

Alternatively, the free cash flow hypothesis suggests that repurchase of shares is a way to distribute a firm's excess cash flow to avoid over-investment (Easterbrook 1984; Jensen 1986). The existence of free cash flows may lead managers to implement poor-performing or highly-risky projects in order to safeguard their own interests to the detriment of the firm values. According to the free cash flow hypothesis, when firms notice the deteriorating future investment opportunities, they will distribute cash flows and use share repurchases in lieu of investments to avoid excess investments. Prior studies suggest that repurchases are more likely in firms that hold high levels of excess cash (Dittmar, 2000; Mitchell and Dharmawan, 2007; Andriosopoulos and Hoque 2013). However, if CEOs' equity incentives are high, the linkage between the personal wealth of CEO and firm value is strong, so the agency problem

resultant from free cash flows will be mitigated (Haugen and Senbet 1981). That implies CEOs' equity incentive can mitigate the over-investment of free cash flow. Therefore, firms with higher equity incentive are less likely to repurchase shares in order to distribute free cash flows. This paper expects that firms with CEOs' high equity incentives can mitigate overinvestment problems due to free cash flows, and are less sensitive to excess free cash flow when taking repurchase decisions. We posit the following hypothesis:

H2b: The relationship between abnormal cash flows and share repurchases decreases with the CEO equity incentives.

Board gender diversity

According to corporate governance literature, female directorsallocate more effort to monitor firms and improve corporate governance (Adams and Ferreira 2009; Zhu, Small and Flaherty 2010; Post and Byron 2015). For example, Nielsen and Huse (2010) find that female directors increase board effectiveness by reducing the level of board conflict and ensuring a high quality of board development activities. Chen, Crossland and Huang (2016) find a negative relationship between female directors and mergers and acquisitions (M&A) according to social identity theory. Post and Byron (2015) also show that female board representation is positively related to board monitoring activities and board strategy involvement due to gender differences in risk aversion and ethical sensitivity. Evgeniou and Vermaelen (2017) indicate that board gender diversity increases the likelihood of repurchase to reduce agency costs of free cash flow.

Prior research related to CEOs equity incentives has two competing effects: the interest alignment effect (Fama and Jensen 1983; Jensen and Meckling 1976; Holmstrom 1979) and the opportunistic effect (or entrenchment effect) (Goldman and Slezak, 2006; Duellman, Ahmed and Abdel-Meguid 2013; Armstrong, Larcker, Ormazabal and Taylor 2013). Duellman et al. (2013) find that the incentive alignment (opportunistic) effect of equity incentives increases (decreases) as monitoring intensity increases (decreases). Cheng, Harford and Zhang (2015) also find that repurchases are more likely in firms when CEO bonus pay is based on EPS. CEOs also attempt to time the market when taking share repurchases decisions (Chan et al. 2007). Zhang et al. (2008) also suggest that equity incentives lead to incentive misalignment.

Given that female directors improve corporate governance (Adams and Ferreira 2009; Zhu, Small and Flaherty, 2010; Post and Byron 2015) and have enough time to monitor the CEOs, this study expects that the opportunistic effect of equity incentives decreases when there are more female directors in the board. Based on the above arguments, we make the following hypothesis:

H3: The relationship between the amount of share repurchase announced and CEOs equity incentives decreases when there are more female directors on the board.

3. Research Design

Our main aim is to examine the impact of CEO equity incentive on share repurchases. To test the first hypothesis, we estimate the following cross-sectional regressions:

$$\begin{aligned} REPURCHASE_{it} = {} & \alpha_0 + \beta_1 H\_INC_{it-1} + \beta_2 ABFCF_{it-1} + \beta_3 ABBM_{it-1} + \beta_4 SIZE_{it-1} + \beta_5 LEVERAGE_{it-1} \\ & + \beta_6 PAYOUT_{it-1} + \beta_7 RET_{it-1} + \beta_8 TENURE_{it-1} + \beta_9 FECO_{it-1} + \beta_{10} DUAL_{it-1} + \beta_{11} BDSIZE_{it-1} \\ & + \theta YEARdummy + \delta INDUSTRYdummy + \varepsilon_i \end{aligned} \quad (1)$$

The dependent variable, $REPURCHASE_{i,t}$ is the amount of share repurchases, scaled by market value at the beginning of the year (multiplied by 100 to report as a percentage) (Dittmar 2000; Blouin and Krull 2009; Banyi et al 2008; Liu and Swanson 2016). The explanatory variable of primary interest, $H\_INC_{i,t-1}$ is *excess* CEO equity incentive at the beginning of the year. Our H1 predicts that the coefficient of $H\_INC_{i,t-1}$ is positive, or $\beta_1>0$, suggesting that repurchases are more likely in firms with more equity incentive.

We follow Core and Guay (1999) in the calculation of the CEO equity incentives. The incentive effect is quantified as the change in the equity value owned by CEOs for each 1% change in share prices. Computing this measure of incentives for stock owned by a firm's CEO is straightforward because stock value increases by 1% for each 1% increase in the stock price (Core and Guay 1999). In addition, Core and Guay (1999) indicate that equity incentives to CEO are subject to the influence of firm size (*lnMV*), operational risks (*RISK*) and growth opportunities (*GROWTH*). Therefore, this paper uses Equation (M1) to address the self-selection bias by estimating the optimal equity incentive and compute the residuals. Positive residuals mean the incentive is higher than the optimal value, and the observations are defined as high incentives. We then define *H_INC* as 1 if the incentive is higher than the optimal value, and zero otherwise. The estimation Equation (M1) is as

follows:

$$INC_{it} = \alpha_0 + \lambda_1 \ln MV_{it} + \lambda_2 RISK_{it} + \lambda_3 GROWTH_{it} + \delta INDUSTRYdummy + \varepsilon_i \quad \text{(M1)}$$

Equity incentives in the form of CEO ownership (*INC*) is defined as the number of shares held by CEOs during the year multiplied by share prices and divided by 100. Firm sizes (*lnMV*) are computed as the natural logarithm of the market value at the beginning of the period, growth opportunity (*GROWTH*) represented by the market-book ratio (market value of equity divide by book value of equity), and operational risks (*RISK*) measured as the residuals in the market returns model.

Prior literature suggests that the repurchase announcement usually serves as a positive economic signal of benefit to investors due to the undervaluation hypothesis and the free cash flow hypothesis (Liu and Ziebart 1997; Chan et al. 2004; Grullon and Michaely 2004; Wu 2012a; Liang et al. 2013). This study thus controls the free cash flow and price undervaluation. We follow Liang et al. (2013) to measure the free cash flows as the abnormal free cash flows ratio (*ABFCF*) and price undervaluation as the abnormal book-market ratio (*ABBM*). First, the free cash flows (*FCF*) are calculated as the cash and cash equivalents deflated by total assets at the beginning of the period (Dittmar 2000). To capture the different effects between repurchase firms and non-repurchase firms, we then match the repurchase sample firm's *FCF* with the potential non-repurchase firms that have the same two-digit SIC industry. The median value for the *FCF* in the non-repurchase sample is used as a benchmark. The FCF of the firms with share repurchase is deducted with the median *FCF* of the matched sample to derive the abnormal free cash flows ratio (*ABFCF*). Similar procedures are applied to the book-market ratio (*ABBM*) with the book-market ratio (*BM*) being the ratio of the book value of equity to the market value at the beginning of the year when share repurchases are announced (Dittmar 2000).

This study includes several control variables that are expected to influence the decision to repurchase share, as shown in Equation (1), including firm size (*SIZE*), debt ratio (*LEVERAGE),* payout ratio (*PAYOUT*) and past stock returns (*RET*). Firm size (*SIZE*) is measured by the natural log of total assets at the end of year t-1 (De Cesari and Ozkan 2015; Liu and Swanson 2016; Chintrakarn, Chatjuthamard, Tong and Jiraporn 2018). Prior studies show that information asymmetry is more serious with small firms; hence, small firms are more likely to be undervalued and to buy back shares. Debt ratio (*LEVERAGE*) is total

liabilities divided by total assets. It is expected that the lower the debt ratios, the more likely share repurchases (De Cesari and Ozkan 2015; Liu and Swanson 2016; Evgeniou and Vermaelen 2017; Chintrakarn et al. 2018; Banerjee et al. 2018). However, some research suggests a positive relation between leverage and repurchase (e.g., Dittmar 2000). Therefore, we do not make a directional prediction about the relationship between leverage and repurchase. Dividend yield is measured as cash dividends divided by net incomes. According to the substitution hypothesis, the companies buying back shares pay out fewer dividends (Liu and Swanson 2016). Finally, Ikenberry et al. (1995) suggest that undervaluation of share prices is often a result of poor share price performance in the past. Therefore, this paper measures share performance with the stock returns (*RET*) before share repurchase announcements, and expects that the lower the stock returns before share repurchases, the more likely the announcements of share repurchases. *RET* is the raw stock return in the previous fiscal year (De Cesari and Ozkan 2015; Evgeniou and Vermaelen 2017; Banerjee et al. 2018)

In addition, the CEO-level characteristics can also influence risk-taking tendencies, affecting the CEOs' incentive to repurchase shares. We also control for CEO-level characteristics as well, including CEO tenure (*EARLY*) (Simsek 2007; Ali and Zhang 2015), female CEO (*FCEO*) (a dummy variable indicating that the CEO was female) and duality (*DUAL*) (the percentage of firm shares held by the CEO). We use an indicator variable that equals one for firm-years that correspond to the first three years of service of the firm's CEO (*EARLY*) as a proxy for experience and potential horizon problems (Ali and Zhang 2015), and zero otherwise. Activist shareholders have argued for the separation of the board chair and CEO, and a number of empirical studies suggest that agency problems are higher when the CEO is also the board chair (e.g., Yermack 1996). We define the dual Chair/CEO (*DUAL*) as an indicator variable, which is equal to one if the board chair is also the CEO, and zero otherwise. In addition, we include board size (*BDSIZE*), the number of directors, to control for governance conditions. All variables are summarized in Appendix A.

In Equation (1), all the independent variables, including CEO equity incentive, are measured at the beginning of the year to reduce concerns about endogeneity and potential revere causality (Burns et al. 2015; De Cesari and Ozkan 2015). We also include industry dummy variables (industry effects) using the two-digit SIC code level and year dummy variables (year effects) to control for possible variation over time and across industries. All

continuous variables are winsorized at the 1% level on each tail to alleviate the influence of outliers. We adjust standard errors from regressions for the clustering effect at the firm level (Petersen 2009).

Most studies focus on whether the self-interest motivation of managers and economic incentives separately affect share repurchases without delving into whether managers' self-interest motivation affects economic incentives in companies' repurchase decision. This paper further examines whether different levels of CEO equity incentives affect the economic incentives related to share repurchases.

We examine two economic incentives (i.e., undervaluation and free cash flows) of share repurchases potentially affected by CEO equity incentive. H2a expects that high equity incentive CEOs are more sensitive to a firm's undervalued stock. We capture this by linking the CEO equity incentive variables (*H_INC*) with the firms' undervaluation (*ABBM*) over the prior year. To test this hypothesis, we add the interaction variables of *H_INC*ABBM* in Equation (2). H2a predicts that a positive relation between abnormal BM ratio (undervaluation) and the amount of repurchase is more pronounced in firms with high CEO equity incentives, resulting in the coefficient of the interaction term *H_INC*ABBM* (β_4) > 0. On the other hand, H2b states that the lower equity incentive weakens the share repurchase economic incentive on the free cash flow distribution. Hence, the coefficient of interaction of *H_INC*ABFCF* (β_5) is negative or insignificant. To test Hypothesis 2, we estimate the following cross-sectional regressions:

$$\begin{aligned} REPURCHASE_{it} = {} & \alpha_0 + \beta_1 H\_INC_{it-1} + \beta_2 ABFCF_{it-1} + \beta_3 ABBM_{it-1} + \beta_4 H\_INC_{it-1} * ABBM_{it-1} \\ & + \beta_5 H\_INC_{it-1} * ABFCF_{it-1} + \beta_6 SIZE_{it-1} + \beta_7 LEVERAGE_{it-1} + \beta_8 RETURN_{it-1} \\ & + \beta_9 PAYOUT_{it-1} + \beta_{10} TENURE_{it-1} + \beta_{11} FECO_{it-1} + \beta_{12} DUAL_{it-1} + \beta_{13} BDSIZE_{it-1} \\ & + \theta YEARdummy + \delta INDUSTRYdummy + \varepsilon_i \end{aligned} \quad (2)$$

Hypothesis 3 expects that the opportunistic effect of equity incentives decreases when there are more female directors on the board. We add *GENDER* and *GENDER*H_INC* in Equation (3) to test H3. *GENDER* is the percentage of female directors on the board, which is used as a measure of gender diversity (Evgeniou and Vermaelen 2017). We also use an alternative measure such as a dummy variable for the presence of female directors on the

board.[6] The negative coefficient of interaction term of *GENDER*H_INC* implies that female directors mitigate the opportunistic effect of CEO equity incentives. To test hypothesis 3, we estimate the following cross-sectional regressions:

$$\begin{aligned} REPURCHASE_{it} = {} & \alpha_0 + \beta_1 H\_INC_{it-1} + \beta_2 ABFCF_{it-1} + \beta_3 ABBM_{it-1} + \beta_4 FEMALE_{it-1} \\ & + \beta_5 FEMALE_{it-1} * H\_INC_{it-1} + \beta_6 SIZE_{it-1} + \beta_7 LEVERAGE_{it-1} + \beta_8 RETURN_{it-1} \\ & + \beta_9 PAYOUT_{it-1} + \beta_{10} TENURE_{it-1} + \beta_{11} FECO_{it-1} + \beta_{12} DUAL_{it-1} + \beta_{13} BDSIZE_{it-1} \\ & + \theta YEARdummy + \delta INDUSTRYdummy + \varepsilon_i \end{aligned} \quad (3)$$

2) Sample Selection and Data Sources

The sample was drawn from Taiwan Stock Exchange Corporation (TWSE) and Taipei Exchange (TPEx) listed companies (excluding financial industries) from 2002 to 2016. Share repurchases, CEO equity incentives, board gender, share prices and financial data were all taken from *Taiwan Economic Journal* (*TEJ*) databases. A total of 2,789 share repurchase announcements were made during 2002 to 2016. After eliminating the financial data that we were unable to determine, the final sample comprised 2,478 share repurchases. Table 1 reports the repurchase announcements by industry and year classification from 2002 through 2016. The number of share repurchases ranges from 64 to 420 during the sample period. The number in 2008, 420, is more than twice as high as in other years. This may be a response to the global financial crisis in 2008, as more companies sought to protect shareholders' rights with share repurchases. In terms of industry distribution, the electronics industry, which is the largest group, accounts for 68% of the sample (with 1,688 companies out of 2,478).

[Insert Table 1 here]

4. Empirical Results Analysis

4.1 Descriptive Statistics

Table 2 summarizes the descriptive statistics of the sample. The mean of the value of repurchased shares deflated with the market capitalization at the beginning of the period (*REPURCHASE*) is 0.017, indicating that the value of repurchased shares accounts for an average of 1.7% of the market value. The average share repurchase amount is NT$170 million. The average *H_INC* is 0.607, implying that 60% of repurchase firms have significantly higher

[6] We also use the number of female directors in the board as the measure, yielding essentially similar results.

CEO equity incentive. The mean of abnormal free cash flow (*ABFCF*) for repurchase companies is 0.025, suggesting that repurchase companies possess significantly higher abnormal free cash flows. This is consistent with literature arguing that free cash flows motivate share repurchases. The mean of the abnormal book-market ratio (*ABBM*) of the repurchase companies is 0.111. This shows that the repurchase firms have high abnormal book-market ratio and their market value is undervalued. This is in line with literature suggesting undervalued share prices are a motivation for share repurchases. Meanwhile, the repurchase firms report lower debt ratios (*LEVERAGE*) and these companies are larger in *SIZE*.

[Insert Table 2 here]

Table 3 reports the Pearson correlation coefficients between the variables used in the multivariate analyses. Repurchase amount (*REPURCHASE*) appears to be highly correlated with CEO equity incentive (*H_INC*) and abnormal book-market ratio (*ABBM*). The correlation coefficients between control variables are generally small in magnitude. The largest correlation is between *ABBM* and *RET* (0.49), which is less than 0.7. In addition, as the VIF statistics for all explanatory variables never exceed 5.0 in any regression model, multicollinearity may not be a serious concern in our study (Zeng and Wang 2015).

[Insert Table 3 here]

4.2 Effect of equity incentives on repurchase

Table 4 reports the results of the relation between CEO equity incentive and share buyback. Column (1) shows the results of the economics incentives on repurchase with adjusted R-squares 0.108. The coefficient of abnormal free cash flows (*ABFCF*) is 0.003 at the 10% significance level, suggesting that the higher the abnormal free cash flows, the larger the value of share repurchases. This result supports the free cash flow hypothesis that firms use share repurchases as a means of distributing free cash flows. The coefficient of abnormal book-market ratio (*ABBM*) is also significantly positive (coefficient=0.008 with $p<0.01$). This is consistent with the information signaling hypothesis that firm undervaluation motivates share repurchases.

Regarding the control variables, the significantly positive coefficient of *LEVERAGE*

shown in column (1) (coefficient =0.008 with $p< 0.01$) suggests that the repurchase amounts increase with a firm's leverage, which is consistent with prior research (Dittmar 2000). The coefficient of *PAYOUT* is significantly negative (-0.000 with p<0.1), indicating that the repurchase firms pay less cash dividend, which is consistent with Evgeniou and Vermaelen 2017. The coefficient of *SIZE* is significantly negative (-0.002 with p<0.01), indicating that the repurchase amount is lower in large firms. Given that the coefficient of *RET* is significantly negative (-0.052 with p<0.1), firms with lower stock returns tend to repurchase shares. Finally, with significantly negative coefficient of *BDSIZE* (-0.005 with p<0.05), repurchases are less likely in firms with larger board size. In sum, the results in column (1) document the signaling and free cash flows motivation in our sample.

Column (2) of Table 4 reports the results of both the economic incentives and the equity incentives on repurchases. We find the coefficient of *H_INC* to be significant and positive (coefficient=0.001, p<0.05). This indicates that firms are more likely to repurchase stocks when the CEO has higher equity incentive. This result provides strong support to H1 that CEOs who want to increase firm value and their personal benefit have the motivation for repurchasing stocks.

To test H2, we added the interaction terms *H_INC *ABBM* and *H_INC *ABFCF*. H2a predicts that the positive relation between abnormal BM ratio (undervaluation) and the amount of repurchase is more pronounced in firms with high CEO equity incentives. The results in column (3) show that the coefficient of *H_INC* is still significantly positive. In addition, the coefficient of *H_INC*ABBM* is 0.002 (p<0.1). The evidence supports H2a that strong equity incentives strengthen the share repurchase economic motivation when share prices are undervalued. On the other hand, the coefficient of *H_INC*ABFCF* is insignificant, meaning that the CEOs with high equity incentive are not sensitive to the firm's abnormal free cash flows. Overall, this paper finds that CEOs with high equity incentives have larger propensity to buy back stocks. However, this larger propensity exists especially when the firms' stock is undervalued. Having higher excess cash flows will not motivate CEOs with high equity incentives to decide to repurchase stocks. These results suggest that the CEO equity incentives intervenes the economic incentives of share repurchases documented in prior studies.

[Insert Table 4 here]

4.3 Effect of female director in the board

To test H3, that the effect of equity incentive on shares repurchase will be weaker when the firms are monitored by more female directors in the board, we captured this by interacting the CEO equity incentive variable with the female directors on the board, based on the strength of internal monitoring by female directors. Table 5 reports the results.

We used two measures of board gender diversity: *GENDER* (the percentage of directors on the board who are female) and *GENDERDM* (1 if there is at least one female director on the board, 0 otherwise) (Chen, Crossland and Huang 2016; Evgniou and Vermaelen 2017). In column (1) of Table 5, we used the percentage of directors on the board who are female (*GENDER*). The coefficient of *GENDER* is positive and significant, indicating that repurchases occur more often in firms with a higher percentage of female directors on the board, which is consistent with prior research (Evgeniou and Vermaelen 2017). In addition, the interaction term *GENDER*H_INC* has a coefficient of -0.009 (p-value = 0.010). The evidence suggests that the effect of equity incentive on repurchase is weaker when firms have more female directors on the board, and have more incentives to monitor CEOs' opportunistic behavior related to share repurchase. In column (2) of Table 5, we add two interaction terms: *GENDER*H_INC*ABFCF* and *GENDER*H_INC*ABBM*. We also find that the coefficient of *GENDER*H_INC*ABBM* is negative and significant, which means that the positive relation between equity incentive and abnormal BM ratio (undervaluation motivation) would be mitigated when firms have a higher percentage of female directors on their boards.

When using *GENDERDM* to measure board gender diversity, columns (3) and (4) show similar results. Therefore, the results in Table 5 are consistent with the prediction of H3, that more female directors on the board represents stronger governance mechanism and decreases the opportunistic behavior of CEOs.

[Insert Table 5 here]

5. Conclusion

Using a sample of the Taiwan Stock Exchange and Taipei Exchange listed companies from 2002 to 2016, this study investigated the effects of both CEO equity incentives and economic incentives on shares repurchase, and further examined the role of board gender

diversity. The evidence suggests that without considering CEO equity incentives, firms buy back shares due to abnormal free cash flows and/or undervalued share prices. This is consistent with prior studies and supports both the free cash flow hypothesis and the information signaling hypothesis. However, when considering the CEOs equity incentives, consistent with our hypotheses, CEOs with higher equity incentives are more likely to buy back shares, in particularly, when the stock is undervalued. This implies that CEO equity incentive affects the economic motivation of repurchase share, and suggests that CEOs with high equity incentive are more sensitive to firm value, but not free cash flows. We also find that the effect of CEOs equity incentives on shares repurchase decreases with board gender diversity, which is consistent with the governance hypothesis that a stronger governance mechanism mitigates the CEOs' opportunistic behavior related to buying back shares in order to increase their personal wealth.

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Table1

Distribution of observations.

Industry/Year	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total
Cement	2	1	1	3	2	1	4	0	0	0	0	0	0	2	1	17
Food	3	3	4	4	0	1	2	0	0	2	0	0	1	1	0	21
Plastics	0	0	5	7	5	4	10	3	1	2	1	0	3	6	2	49
Textiles	5	5	10	6	5	4	15	9	3	9	3	5	3	6	1	89
Electric, Machinery	10	10	13	6	5	7	17	6	3	13	9	2	6	10	5	122
Appliance, Cable	4	1	1	2	1	0	4	1	1	1	0	0	1	3	1	21
Chemical	4	5	12	5	5	1	14	3	1	13	4	2	8	20	10	107
Glass, Ceramics	0	0	0	0	0	0	3	0	0	2	0	0	0	1	1	7
Paper, Pulp	1	1	1	2	1	1	2	2	0	1	1	1	1	1	0	16
Steel, Iron	1	0	3	6	4	1	10	3	0	5	9	2	4	9	5	62
Rubber	0	1	2	2	2	1	3	0	1	2	1	0	1	1	2	19
Automobile	0	2	3	0	0	2	2	0	0	0	1	0	0	2	2	14
Electronics	51	71	176	108	105	124	296	55	48	166	90	56	58	187	97	1,688
Construction	10	4	8	7	6	6	13	2	2	10	6	2	11	9	8	104
Transportation	1	0	1	1	0	1	5	3	1	1	2	1	1	4	3	25
Tourism	0	2	1	1	0	2	3	1	0	0	1	0	2	3	3	19
Trading and consumers' Goods	3	5	4	3	1	3	5	1	1	3	2	1	1	4	1	38
Other	3	3	4	5	1	1	12	5	2	7	4	2	1	6	4	60
total	98	114	249	168	143	160	420	94	64	237	134	74	102	275	146	2,478

Table 1 reports the repurchase announcements by year and industry classification from 2002 through 2016.

Table 2
Descriptive Statistics (n=2,478)

	Mean	Median	SD	p25	p75	Min	Max
Repamount (NT$ million)	170	39	1209	16	98	0.000	484677
REPURCHASE	0.017	0.013	0.018	0.006	0.023	0.000	0.251
H_INC	0.607	1.000	0.489	0.000	1.000	0.000	1.000
ABFCF	0.025	-0.010	0.120	-0.049	0.056	-0.114	1.118
ABBM	0.111	-0.001	0.537	-0.259	0.358	-0.894	4.900
LEVERAGE	0.351	0.351	0.153	0.233	0.459	0.003	0.851
PAYOUT	1.566	0.359	20.131	0.000	0.823	-18.944	864.182
SIZE	15.336	15.147	1.236	14.477	16.054	12.424	20.129
RET	-0.000	-0.002	0.006	-0.004	0.001	-0.009	0.080
GENDER	0.136	0.111	0.129	0.000	0.200	0.000	0.750
EARLY	0.078	0.000	0.269	0.000	0.000	0.000	1.000
DUAL	0.358	0.000	0.479	0.000	1.000	0.000	1.000
FCEO	0.034	0.000	0.181	0.000	0.000	0.000	1.000
BDSIZE	9.362	9.000	2.089	8.000	10.000	4.000	32.000

1. All variables are defined in Appendix A.

Table 3

Correlation between variables

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	*REPURCHASE*	1.00												
(2)	*H_INC*	0.07***	1.00											
(3)	*ABFCF*	-0.03	0.00	1.00										
(4)	*ABBM*	0.24***	0.01	-0.22***	1.00									
(5)	*LEVERAGE*	0.03	0.02	-0.23***	-0.05***	1.00								
(6)	*PAYOUT*	-0.03	-0.02	0.02	-0.04**	0.01	1.00							
(7)	*SIZE*	-0.12***	-0.30***	-0.18***	0.08***	0.23***	0.02	1.00						
(8)	*RET*	0.21***	-0.08***	0.05**	0.49***	-0.03	-0.04*	0.00	1.00					
(9)	*GENDER*	0.02	0.02	-0.03	-0.03	0.03	0.01	-0.07***	-0.01	1.00				
(10)	*EARLY*	0.00	-0.07***	-0.02	0.01	0.02	0.01	-0.04**	-0.02	-0.02	1.00			
(11)	*DUAL*	0.03	0.06***	0.01	0.01	-0.06***	-0.03	-0.13***	0.02	0.11***	-0.08***	1.00		
(12)	*FCEO*	-0.01	-0.02	-0.02	-0.02	-0.00	-0.01	0.07***	0.01	0.17***	-0.02	-0.04*	1.00	
(13)	*BDSIZE*	-0.08***	-0.08***	-0.02	0.01	0.01	0.00	0.22***	-0.01	-0.08***	-0.05**	-0.10***	0.03	1.00

1. All variables are defined in Appendix A.

2.***, **, and * indicate statistical significant at the 1%, 5%, and 10% levels, respectively.

Table 4 Equity incentive and motivation of repurchase

	(1)	(2)	(3)
Intercept	0.066***	0.054***	0.050***
	(0.000)	(0.000)	(0.000)
ABFCF	0.003*	0.003*	0.002
	(0.055)	(0.059)	(0.146)
ABBM	0.008***	0.009***	0.007***
	(0.000)	(0.000)	(0.000)
H_INC		0.001**	0.001*
		(0.015)	(0.065)
*H_INC*ABFCF*			0.001
			(0.129)
*H_INC*ABBM*			0.002*
			(0.057)
LEVERAGE	0.008***	0.008***	0.008***
	(0.006)	(0.009)	(0.007)
PAYOUT	-0.000*	-0.000**	-0.000**
	(0.096)	(0.041)	(0.023)
SIZE	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)
RET	-0.052*	-0.010	-0.028
	(0.092)	(0.718)	(0.348)
EARLY	0.000	0.000	0.000
	(0.583)	(0.793)	(0.611)
DUAL	0.000	0.000	0.000
	(0.854)	(0.823)	(0.683)
FCEO	0.000	0.000	0.000
	(0.929)	(0.940)	(0.919)
BDSIZE	-0.005**	-0.004**	-0.004**
	(0.034)	(0.024)	(0.030)
Year dummy	Controlled	Controlled	Controlled
Industry dummy	Controlled	Controlled	Controlled
N	2,478	2,478	2,478
adj. R^2	0.108	0.105	0.107

1. All variables are defined in Appendix A.
2. Coefficient estimates are reported with p-values in parentheses. ***, **, and * indicate statistical significant at the 1%, 5%, and 10% levels, respectively. All continuous variables have been winsorized at the 1 percent and 99 percent levels. This table presents the regression results from Equations (1) and (2). The coefficient estimates are based on firm clustered standard errors (Petersen 2009).

Table 5 Effect of Board gender diversity on equity incentive

	(1)	(2)	(3)	(4)
Intercept	0.050***	0.051***	0.053***	0.049***
	(0.000)	(0.000)	(0.000)	(0.000)
*GENDER*H_INC*	-0.009**	-0.007**		
	(0.010)	(0.049)		
*GENDER*H_INC*ABFCF*		-0.003		
		(0.844)		
*GENDER*H_INC*ABBM*		-0.023***		
		(0.000)		
GENDER	0.007**	0.008**		
	(0.026)	(0.015)		
*GENDERDM*H_INC*			-0.001**	-0.001**
			(0.014)	(0.038)
*GENDERDM*H_INC* ABFCF*				-0.001
				(0.895)
*GENDERDM*H_INC* ABBM*				-0.008**
				(0.025)
GENDERDM			0.001*	0.001**
			(0.098)	(0.030)
H_INC	0.002**	0.002***	0.001**	0.001**
	(0.040)	(0.006)	(0.030)	(0.041)
*H_INC*ABFCF*		0.002		0.005
		(0.333)		(0.272)
*H_INC*ABBM*		0.005***		0.008**
		(0.001)		(0.017)
ABFCF	0.003**	0.001	0.003**	0.001
	(0.013)	(0.425)	(0.047)	(0.732)
ABBM	0.009***	0.007***	0.008***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
LEVERAGE	0.007**	0.007**	0.007***	0.007***
	(0.020)	(0.018)	(0.006)	(0.009)
PAYOUT	-0.000**	-0.000***	-0.000**	-0.000**
	(0.037)	(0.005)	(0.024)	(0.011)
SIZE	-0.002***	-0.002***	-0.002***	-0.002***
	(0.001)	(0.000)	(0.000)	(0.000)
RET	0.068**	0.063**	-0.041	-0.046
	(0.014)	(0.021)	(0.169)	(0.129)
EARLY	0.000	-0.000	0.001	0.000
	(0.724)	(0.822)	(0.441)	(0.557)
DUAL	0.000	0.000	0.000	0.000
	(0.728)	(0.716)	(0.786)	(0.700)
FCEO	-0.000	-0.000	0.000	-0.000
	(0.955)	(0.874)	(0.905)	(0.999)
BDSIZE	-0.004**	-0.004**	-0.006**	-0.005**
	(0.030)	(0.018)	(0.011)	(0.014)
Year dummy	Controlled	Controlled	Controlled	Controlled
Industry dummy	Controlled	Controlled	Controlled	Controlled
N	2,478	2,478	2,478	2,478
adj. R^2	0.094	0.100	0.104	0.111

1. All variables are defined in Appendix A.
2. Coefficient estimates are reported with p-values in parentheses. ***, **, and * indicate statistical significant at the 1%, 5%, and 10% levels; respectively. All continuous variables have been winsorized at the 1 percent and 99 percent levels. This table presents the regression results from Equation (3). The coefficient estimates are based on firm clustered standard errors (Petersen 2009).

Appendix A Variable definitions

Variables		Description
Dependent variable		
REPURCHASE	Repurchase amount	The dollar amount of repurchases divided by the prior year end market value of equity (Dittmar 2000; Haw, Ho, Hu and Zhang 2011).
Independent variables		
ABFCF	Abnormal free cash flows	Free cash flow ratios of the repurchase companies minus the median of the free cash ratios of the companies in the matched sample. Free cash flow ratios are cash and cash equivalents deflated by total assets at the beginning of the period. Median of the cash free flow ratios is calculated from the companies in the same industry which do not repurchase shares.
ABBM	Abnormal book-market ratio	Book-market ratios of the repurchase companies minus the median of the ratios in the matched sample. Book-market ratios are book value of ordinary shares divided by market capitalization at the beginning of the quarter when share repurchase announcements are made. The matched sample comprises of the non-repurchase companies in the same industry.
INC	CEO's holding of equity incentive	We define equity incentives as the change in the dollar value of the CEO' s stock for a 1% change in the stock price. log[No. of shares holding * year-end share price/100]
H_INC	High equity incentives	H_INC=1 if the residualfrom equation (M1) is positive, otherwise H_INC=0.
GENDER	Board gender diversity	The percentage of directors on the board who are female (the number of female directors in a given firm-year divided by total board size).
GENDERDM		An indicator variable, which is equal to one 1 if there is at least one female director in the board, and zero otherwise.
Control variables		
SIZE	Firm size	Natural logarithm of total assets.
LEVERAGE	Debt ratio	Total debt divided by total assets.
PAYOUT	Dividend yield	Cash dividends divided by net income.
EARLY		An indicator variable that equals one for firm-years that correspond to the first three years of service of the firm's CEO.
FCEO		A dummy variable indicating that the CEO was female, and zero otherwise.
DUAL		An indicator variable, which is equal to one if the board chair is also the CEO, and zero otherwise.
BDSIZE		Number of directors.
YEARdummy		Dummy variable for years.
INDUSTRYdummy		Dummy variable for industries.
Equation (M1) independent variables		
lnMV	Market value	Natural logarithm of market value at the beginning of the period.

RISK	Operational risks	Residuals of the market model.
GROWTH	Growth opportunity	Market-to-book ratio.